PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
H02G 11/02, H01B 7/08

A1

(11) International Publication Number: WO 00/67353

(43) International Publication Date: 9 November 2000 (09.11.00)

(21) International Application Number: PCT/US00/11446

(22) International Filing Date: 28 April 2000 (28.04.00)

(30) Priority Data:
60/132,015 30 April 1999 (30.04.99) US
60/177,784 24 January 2000 (24.01.00) US

(71) Applicant (*for all designated States except US*): PRECO NEW PRODUCTS, INC. [US/US]; 287 N. Maple Grove, Boise, ID 83704 (US).

(72) Inventor; and
(75) Inventor/Applicant (*for US only*): WHEELER, Edwin, Lee [US/US]; 287 N. Maple Grove, Boise, ID 83704 (US).

(74) Agents: PEDERSEN, Ken, J. et al.; Pedersen and Company, PLLC, P.O. Box 2666, Boise, ID 83701-2666 (US).

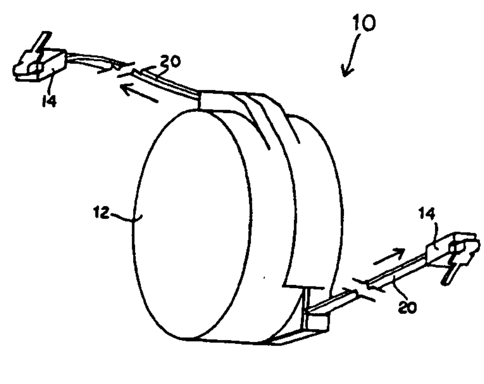
(81) Designated States: AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GE, GH, GM, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

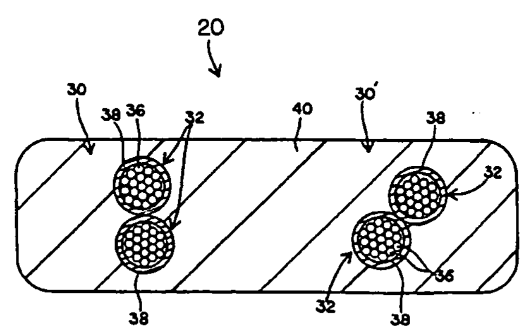
Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: CORD RETRACTOR AND CABLE FOR HIGH SPEED DATA TRANSMISSION

(57) Abstract

Embodiments of a cable (20) and cable/cord retractor (10) are described, the cable (20) including a plurality of twisted pairs (30) of insulated wire in a flat insulator casing adapted to wind and unwind into/out of a retractor. The retractor (10) may be designed according to the invention owner's prior disclosures of cord/cable retractors, or, more preferably, may be a specially-designed, heavy-duty retractor. By using the invented combination of stranded wire or tinsel wire of preferred gauge, composition, and wire coating thickness and material; a preferred twist configuration for the wires; and a preferred outer insulation of particular composition and dimensions, the resulting cable (20) is surprisingly flexible and effective both for retractor use and high speed data transmission. The resulting cable (20) is durable enough to work within a compact retractor (10), while having impedance, attenuation, and cross-talk performance that make it appropriate for Category 5 high speed data transmissions. With the invented cable (20), a retractor may be placed on a modem or in a LAN system, for example, for convenient, safe, and neat handling of Cat 5 cables. The invented flat cable (20) is preferably only about 0.04–0.07 inches thick, so that a reasonable length, such as 3–25 feet, of cable for office and LAN use may easily wind up inside a reasonably-sized retractor (10).





FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

CORD RETRACTOR AND CABLE FOR HIGH SPEED DATA TRANSMISSION

DESCRIPTION

BACKGROUND OF THE INVENTION

Field of the Invention.

This invention relates generally to high quality, high speed data transmission cable for local area networks (LAN), ETHERNET, and other computer applications. More specifically, this invention relates to a Category 5 ("Cat 5") cable that is so compact, flat, and flexible that it takes up little space, eliminates the tangling and clutter of conventional Cat 5 cable, and easily and unobtrusively bends around curves and corners and under carpets. The invented cable is so compact, flat, and flexible that it can be used in compact automatic retractor/wind-up devices of the type that previously have been used only for telephone lines.

Related Art.

High speed data transmission cable meeting Category 5 specifications must be capable of transmitting data up to 100 megahertz within low attenuation and low cross-talk. Standards for Category 5 cable performance have been established by the Telecommunications Industry Association (TIA). The specifications are shown as "limits" in Figure 7A. A glossary including Category 5 and other TIA terminology is included at the end of this section as Table 1.

Conventionally, Cat 5 cable is made of a bundle of twisted pairs in an air space in the central space of a tubular conduit or jacket. Conventional Cat 5 cable, therefore, is bulky, inflexible, and difficult to work with, and therefore results in computer networks that are unattractive and cluttered in appearance. Typically, conventional Cat 5 cable is circular in cross-section and flexes only enough to be easily curved into about a 5 inch radius. Therefore,

Cat 5 cable is handled by placing it in large loops or gradually-curved runs of cable in patch panels, junctions boxes, behind desks, along walls, and under rugs. Conventional Cat 5 cable is largely responsible for the well-known tangle of bulky cables behind personal computers and in LAN systems.

Electrical cord wind-up devices have been designed for thin, flat telephone cables. For example, conventional telephone cord retractor devices, and telephone cords for use therein, are disclosed in U.S. Patents Number 4,646,987, 5,114,091, 5,230,481, 5,354,954, 5,516,986, 5,655,726, and 5,797,558. The disclosures of these patents, including their figures, is incorporated herein by reference. These retractors are typically about 2 inches in diameter, and wind the flat, thin telephone cord on a very tight radius of less than about 1 inch.

To the inventor's knowledge, no Category 5 cable has been developed previously that is thin enough, flat enough, and flexible enough to be used in a wind-up retractor. Especially, no cable has been developed that may be smoothly, consistently, and repeatedly pulled out from, and retracted into, a compact casing preferably less than 5 inches in diameter, and more preferably less than 3 inches in diameter. Therefore, there is still a need for a cord wind-up device and cord/cable that are suitable for high speed data transmission, for example, in the case of high speed modem lines or LAN lines. There is a need for cable that can handle data transmission up to about 100 megahertz within low attenuation and low cross-talk, and yet is flexible, compact, and durable for use in a wind-up retractor. The instant invention addresses this need.

///

///

///

///

///

///

///

TABLE 1

Continuity	The proper installation of a cable, such that each wire connects to the same pin of the connectors on each end of the cable.
Crosstalk	Electromagnetic coupling of the signal from the transmit pair to the receive pair within a cable.
Cursor	A graphical method of identifying where the current point of reference is on the WireScope screen. WireScope uses a few different types of cursor, including reverse video type (white characters against a black background), a vertical line (to identify a single point on the horizontal axis of a graph), and a black triangle (to point to entries on a list). Pressing WireScope's arrow keys moves the cursor.
Data-grade	High quality twisted pair cable, designed to meet the requirements of high speed digital data transmissions.
Ethernet	A Local Area Networking technology which operates at the data rate of 10 Mbps, using a collision detection protocol (CSMA/CD) to manage data flow. Ethernet-type networks are defined in the IEEE 802.3 standards. There are new standards, such as 100Base-T under development for 100 Mbps Ethernet.
Far End Devices	The device connected at the far end of the cable under test used for termination or signal generation. Valid far end devices for testing with WireScope include Scope's Loopback Plug and Remote Reference.
Fault	A problem within the cable causing a signal to be misdirected. A fault could be the result of manufacturing errors, or installation errors, such as shorts, opens or miswires.
Highlight	The visual equivalent of moving the cursor to a particular item on the screen. When using the reverse video cursor, WireScope changes the current item to white characters on a black background to identify it as the current item.
ISDN	Integrated Services Digital Network

ISO 11801	A Draft International Standard, titled "Information Technology- Generic cabling for customer premises cabling", developed by the International Organization for Standardization and the International Electrotechnical Commission. ISO 11801 classifies installed links into classes A, B. C, and D.
kHz	Kilohertz (1,000 Hertz).
LAN	Local Area Network
Category 3	Twisted pair cable used for telephone signaling and Local Area Network protocols with data signaling under 16 MHz.
Category 4	Twisted pair cable, used for Local Area Network protocols with date signaling under 20 MHz.
Category 5	The highest quality twisted pair cable for supporting fast Local Area Networks with data signaling up to 100 MHz in bandwidth.
Class A	ISO-11801 application class. Applications include speech band and low frequency applications. Copper cabling links supporting Class A applications are specified up to 100kHz.
Class B	ISO-11801 application class. Applications include medium bit rate data applications. Copper cabling links supporting class B applications are specified up to 1 MHz.
Class C	ISO-11801 application class. Applications include high bit rate data applications. Copper cabling links supporting Class C applications are specified up to 16 MHz.
Class D	ISO-11801 application class. Applications include very high bit rate data applications. Copper cabling links supporting Class D applications are specified up to 100 MHz.
TIA	Telecommunications Industry Association

SUMMARY OF THE INVENTION

The present invention comprises an electronic data transmission cable, which surprisingly can meet Category 5 ("Cat 5") specifications while also being flexible, durable, and compact enough to work well in a cord winding/un-winding device for computers and other electronic equipment. The invention also comprises the combination of the invented cable and the winding/un-winding device, herein called a "cord retractor" or "retractor," wherein the cord retractor allows repeated extension and retraction of the cable in one or more directions from the retractor. The invented cable is adapted for Cat 5 use in that it carries high speed signals over a wide range of frequencies, at least up to high speed transmission at about 100 megahertz, with low attenuation and low cross-talk. The invented cable is a flat, thin, and flexible cable that is durable throughout thousands of extensions from, and retractions into, the retractor. Specifically, up to about 25 feet of the invented cable exhibits attenuation of less than about 5 dB, and typically less than about 2dB, over the entire 1-100 MHZ range, that is, substantially less than the TIA-568 limit that curves from about 10 dB at 20 MHZ to about 22 dB at 100 MHZ. Specifically, up to about 25 feet of the invented cable exhibits cross-talk preferably at least 10 db, and more preferably at least 10-15 dB, better than the cross-talk TIA-568 standard limit which curves from about 45 dB at 10 MHZ to about 35 db at 100mHz.

These objects of low attenuation, low cross-talk, flexibility, and durability are accomplished in the present invention by supplying a flat cable in the cord retractor, the cable comprising an outer insulation preferably completely surrounding a plurality of wires, and the cable having two generally flat sides and being relatively thin from front side to back side. The preferred cable has a thickness less than or equal to ½ the width of the cable, and more preferably less than or equal to about 1/4 the width of the cable. The invented cable has preferably two or more twisted pair of flexible and durable wire inside the flat insulation, which may be stranded wire or tinsel wire. Each wire of each pair is preferably covered with a very thin coating of low dielectric material, or, alternatively, the coatings of each wire of each pair may be fused together to secure the two wires together and create a more continuous "envelope" of low dielectric material around the pair. Preferably, there are no air spaces between the insulation and the coated twisted pairs of wire, that is, the insulation is in close contact with the wire coating and the coating is in close contact with the wire strands or tinsel ribbons. Each of

the two wires of each twisted pair has preferred particular parameters, that, in combination with the preferred outer insulation of a preferred thickness and composition, allow the wire to repeatedly flex without damage while being capable of transmitting high speed signals appropriate for Cat 5 applications. These particular parameters may be acquired by using the preferred stranded wire or the preferred tinsel wire, and by using the preferred thin wire coating of specific materials.

Another object of the present invention is to provide an improved retractor that smoothly and quietly retracts Cat 5 cables according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A is a schematic perspective view of one embodiment of the invented cord retractor, that is a double-pull retractor shown with both of the opposing cables being extended.

Figure 1B is a schematic perspective view of another embodiment of the invented cord retractor, that is a single-pull retractor with its one extendable cable being extended.

Figure 2A is a schematic perspective view of an Ethernet "hub" for conference table use including a plurality of cord retractors and cables according to the present invention.

Figure 2B is a schematic perspective view of a conference table Ethernet hub having 8 retractors according to the invention.

Figure 2C is a schematic front view of a patch panel including a plurality of cord retractors and cables according to the present invention.

Figure 3A is a schematic top view of a portion of the cable of Figure 1A and B1, assuming the twisted wire pairs are visible through clear insulation.

Figure 3B is a schematic top view of a portion of another embodiment of a cable with different lay for the two twisted pair of wires.

Figure 4 is a cross-sectional end view of the cord of Figure 3D, viewed along the line 4-4 in Figure 3D.

Figure 5A is a cross-sectional end view of another embodiment of a cable according to the invention, using seven-strand wire.

Figure 5B is a cross-sectional end view of another embodiment of a stranded-wire version of the invented cable wherein the wire coating of the twisted pairs is fused together.

Figure 5C is a cross-sectional end view of an embodiment of the invented cable, pointing out various dimensions of interest.

Figure 6 is a perspective cross-sectional end view of an alternative embodiment of a cable according to the invention, which comprises twisted pairs of tinsel wire, shown with the wire coating and insulation removed from the tinsel wire for ease of illustration.

Figure 7A is a plot of test data from Category 5 testing of a stranded cable, of 0.073 inch thickness, according to one embodiment of the invention

Figure 7B is a plot of cross-talk test data from Category 5 testing of a stranded cable, of 0.05 inch thickness, according to the embodiment of Figure 5A, with twists of the wire in the same direction.

Figure 7C is a plot of attenuation test data from Category 5 testing of the stranded cable of Figure 5A.

Figure 8 is an exploded view of one embodiment of a retractor cooperating with the invented cable (the spring and cable not shown).

Figure 9 shows a perspective view of a plate of the retractor of Figure 8 on which the extendible cable is to be wound.

Figure 10 is a side view of the plate of Figure 9, showing the cable wound around the ridge of the plate and the cable being extended.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the Figures, there are shown several, but not the only, embodiments of the invented cable and retractor with the cable. In Figure 1A, retractor 10 is a double-pull retractor including casing 12 containing a winding mechanism, and, optionally, a ratchet mechanism for releasably and temporarily holding the extended cable 20 in place until it is desired to retract it again. Two lengths of cable 20 extend out from the casing 12 in two generally opposing

directions and each have a connector commonly called a "modular plug" 14 on their distal ends for electronic communication between two devices, for example, two devices in an Ethernet, or two outlets of a patch panel.

In Figure 1B, retractor 10' is a single-pull retractor also including casing 12' with a winding mechanism, and, optionally, a ratchet mechanism. One length of cable 20 extends out from the casing 12' in one direction so for connection of its plug 14 to an electronic device. The casing 12' includes a generally stationary plug 15 or other connector for connection to another device, for example, to adapt the retractor 10' for use inside a computer Ethernet device or other LAN device.

Figure 2A illustrates one possible use of retractor 10' and cable 20 in a hub 100 on a conference table 102 or other multi-computer station environment. By including a plurality of single-pull retractors 10' in the hub 100, specifically four in this embodiment, the hub can accommodate a plurality of laptop computers 104 in a neat, untangled configuration. Only the cables in use need be pulled out, and, therefore, no cables are left tangled or trailing on the table. This hub design is optimum for training classes, group design sessions, newsdesks, and other stations in which a plurality of laptops or computers are to be used but space is limited or a more professional, organized appearance is desired.

Figure 2B illustrates another embodiment of a hub for computer conferencing, specifically a hub 110 with 8 retractors 10' for 8 cables 20 for attachment to laptops 104 or other systems.

Figure 2d illustrates another use of an embodiment of the invented double-pull 10 retractor 10 and cable 20, that is, a patch panel 120 or other structure for allowing connection of various Ethernet or other computer wiring. Compared to the traditional jumble and loops of bulky Cat 5 cables in such a junction, the retractors greatly improve the neatness and case of identification of the cables.

Construction of several embodiments of the invented cable are further illustrated in Figures 3 - 6. Experimental data of the invented cable compared to Cat 5 specifications is shown in Figures 7A - C, and an example of retractor construction is shown in Figures 8-10.

Cable 20 includes at least two twisted pair 30, each pair 30 being made of two wires 32 twisted around each other in a long, tight twist, as portrayed in Figure 3A. The preferred combination is two twisted pair, but some embodiments will include more pairs, for example,

four twisted pair or more for increased speed of transmission. Preferably, twisting is in the same direction for all pairs, which is believed to improve cross-talk performance. The twisting of the various pairs is preferably in the range of a lay of 0.7 - 1.0 inches. An especially-preferred embodiment, shown in Figure 3B, has two twisted pair that each have a different lay, which is believed to improve cross-talk between the pair and to improve attenuation of the wires. A preferred configuration is to twist one of the twisted pairs to have a lay of about 0.866 inches, as measured from A-A in Figure 3B. The other pair of a two pair embodiment preferably has. a 0.75 inch lay, that is, one twist in about 0.75 inches, as measured from B-B, as shown in Figure 3B. In any case, it is preferred to have the wires twisted around each other in a tight manner, wherein "tight" means that preferably there is little or no space between the two wires of each pair as they extend around each other.

Each wire 32 of each twisted pair 30, 30' may be stranded wire, as illustrated in Figures 4 and 5A-C. For example, stranded wire in the range of about 26-32 wire gauge (American Wire Gauge-AWG), and preferably 32 gauge, is used. The core of each wire comprises a plurality of conductive strands 36 surrounded by an insulating coating 38. The preferred strands 36 are made of solid oxygen-free copper, but strands of cadmium-copper (about 2% Cd) and tin-copper alloy (about 2% Sn), or with tin or silver coating, may also be used, for example.

Figure 4 illustrates one number and geometry of strands, that is, nineteen strands 36 arranged with a single strand in the center and two layers of strands surrounding the center strand. In this embodiment, the nineteen strands are a fine gauge, that is, about 0.003 inches or 40 gauge, because this large number of strands of fine gauge is excellent for high speed transmission while preserving a high degree of flexibility of the twisted pairs 30 and the cable 20. Once coated with the preferred coating, these nineteen strands result in a wire of approximately 26 AWG. Alternatively, up to about 27 strands of conductive wire are expected to be practical for twisted stranded wire embodiments, with the individual strands being of smaller diameter to result in the preferred 26 -32 AWG wire, that is, preferably in the range of about 8-14 thousands of an inch diameter.

Alternatively, other strand arrangements are included in the invention, that is, the seven-strand embodiment of Figure 5A, in which the core of each wire 32' consists of seven strands 36' arranged with one strand at the center surrounded by six strands. One seven-strand embodiment uses 26-gauge wire 32' that includes strands 36' that are each 36 gauge and made

of copper with tin coating. Alternatively, another high quality cable meeting Cat 5 specifications has been made that includes 32 AWG (.008 inch nominal diameter) twisted wires, each being made of seven strands of oxygen-free copper coated with a Teflon coating.

An especially-preferred embodiment is shown in Figure 5B, which is also stranded wire with a total of 7 strands. This 32 AWG wire 32" preferably includes a central strand 37 of 40 gauge steel, surrounded by six strands 39 of 40 gauge 99.9% oxygen-free copper. Such steel-core stranded wire gives excellent fatigue strength and flexibility, which lead to longer life that all-copper stranded wire, with only about a 5/1000 ohm resistance change compared to all-copper stranded wire. Alternatively, more than one center strand may be made of steel, for example 3-7 center strands, with copper strands or tin- or silver-coated copper strands around the steel core strands. Also, as shown in Figure 5B, the coatings 38' around the wires of the twisted pairs optionally are fused together, to secure the wires together and prevent any untwisting, which results in more consistent and high quality performance, that is, consistently low attenuation and cross-talk.

An alternative embodiment of cable 120 comprises twisted pairs of tinsel wire 132, rather than stranded wire. Such an embodiment, shown in Figure 6, preferably includes 30 AWG (.0103 inch nominal diameter) copper-cadmium tinsel wire 132. A copper-cadmium tinsel wire may include a core 134 of strong and flexible material, such as Kevlar™, nylon or polyester filaments, and two conductive tinsel ribbons 136 wound around the core in the same direction. The ribbons may also be oxygen-free copper, optionally with a silver-plated coating, or other conductive materials. FEP coating 38 preferably surrounds each of the tinsel wires and fills the space between the insulation 40 and the ribbons 136. Other tinsel wire compositions may be used.

In any arrangement, diameter, and number of strands, or in any design and diameter of tinsel wire, the insulating coating 38 is preferably very thin relative to that of conventional wires, and this thinness of insulating coating has been found to greatly enhance flexibility for the resultant cable 20. The preferred insulating coating 38 is less than or equal to about 0.0085 inches thick, with a very slight tolerance, measured from the outside of the strands to the outer diameter of the wire. The preferred insulating coating 38 is selected from a group of Teflon™, polyvinyl chloride (PVC), FEP, or other low dielectric materials. An especially-preferred coating with a constant thickness in the range of 0.003 - 0.005 inches measured from the outside

of the strands or tinsel wire to the outer surface of the coating has been used with excellent results. Within this range, 0.003 inches is the most preferred thickness, and the inventor believes that 0.002 inches also may be advantageous in terms of high flexibility with appropriate insulating characteristics.

The especially preferred coating material is fluorine-ethylene-propylene (FEP) coating, which, in a thickness of 0.003 inches, has been shown to result in a highly flexible, durable, and compact cable when used as a coating over both 7-stranded wire and also tinsel wire. The FEP coating, has been determined to provide the preferred low dielectric constant, while holding strands or tinsel ribbons in well in place, being easily separable from the outer insulator of the cable described below, and being UL-approved. Other fluorocarbon materials, such as Teflon™, may be used and are beneficial because of the ease of stripping away from the outer insulation. The FEP coating is believed to be especially advantageous because it efficiently secure the ribbons of the tinsel wire in place during repeated extensions and retractions of the cable in the cord retractor.

Optionally, as mentioned above, each wire pair may be treated to fuse the FEP-coating 38' of the two wires together so that FEP coating extends entirely around each wire of the each pair, but the two wires of each pair are secured together at a consistent distance from each other. Preferably, this is done only to an extent that connects the two wires together at a consistent distance along the length of the wires, preserving and retaining their spacing from each other. This fusing is believes to provide a more stable, durable and consistent wire pair in the cable, which is important for long term durability of the cable during repeated winding and unwinding and/or repeated flexing of the cable for other purposes. This fusing may be done by various methods, for example, gentle heating that slightly softens the FEP but does not disrupt the complete coverage of the wire by the FEP.

After twisting, each twisted pair may be described as having a nominal diameter of approximately 0.05 inches or less. The preferred twisted pairs, of 32 gauge wires and the 30 gauge wires, with the extremely thin coatings, may be described as having nominal diameters of 0.04 inches and 0.028-0.032 inches, respectively.

Around the twisted pairs is outer insulation 40, the outer surface of which forms the thin, flat flexible cable 20 of the invention. The cable may be considered generally rectangular in cross-section, with preferably rounded corners, and is preferably about 0.13-0.17 inches wide

(W) and about 0.073 inches thick (T) or less. The preferred dimensions result in a thickness that is less than or equal to ½ of the width, for example, about a 0.073 inch thickness compared to about a 0.15 inch width, or, preferably less, for example, a thickness less than or equal to 1/4 of the width (0.04 inch thickness compared to 0.16 inch width). Especially-preferred embodiments, using 32 gauge 7-stranded wire or 30 gauge tinsel wire, have a thickness of about 0.05 inch or, more preferably, 0.38-0.041 inch thickness. The preferred generally flat cable of 0.04 inch thickness may be wound into the casing with surprising ease and with surprisingly little "memory," even after being wound tightly to less than an inch radius, that might be expected to curve the cable when extending out from the casing.

Insulation 40 may be a thermoplastic material specially designed for both flexibility and for EMF/EMI reduction between pairs 30, 30' for low cross-talk between pairs. The preferred insulation 40 is PeBax™ extruded closely around the twisted pairs, to form a layer around the pair 30, 30', with preferably no air space between the twisted pair and the insulation 40 and with no cavities inside the cable beside the cavities filled by the coated twisted wires. The insulation 40 insulates the pairs from the outside environment and also from each other, that remains flexible and durable through thousands of windings and unwindings, and that inhibits cross-talk between the pairs. PeBax™ is available from Autochem and is a preferred embodiment of the general category of Block Polyamides that may be used for the insulation.. PeBax™ insulation features good dielectric qualities, good abrasion resistance, and is easy to extrude and strip away from the coated twisted wires. Preferably, a fire resistant/flame retardant material may be added to the Pebax™, for example, a strontium fire retardant, or Teflon materials such as Zonal ™ which, in small percentages in the insulation 40, will act as a fire retardant and will improve the cable coefficient of friction for even easier extending and retraction of the cable. Optionally, other materials may be used for the insulation 40, for example, PVC, polyester elastomers, polyolefins, preferably with fire-retardant properties or fire-retardant additives as necessary to adapt the invented cable for UL approval. Thermoplastic polyester resin, such as Rynite™ by Dupont, or a ionomer resin, such as Surlyn™ by Dupont, are alternatives for insulation to be extruded around the twisted pairs of the invention.

The PeBax™ insulation may be clear, or, optionally, black or other colorant may also be added, and a preferred colorant is of the general category of carbon black, and is available from

Clairiant Reed Spectrum. Preferably the black colorant is mixed in a ratio of about 0.15 wt% pure black colorant in PeBax™. In practice, the preferred method of mixing the colorant with the PeBax™ is to obtain a first extruded mixture of pure black colorant in PeBax™ (about 1 part colorant to 25 parts PeBax™ by weight), and then further mix the extruded mixture with more PeBax™ (about 1 part of the mixture to 25 parts PeBax™ by weight) for melting and extrusion of the final mixture around the two twisted pairs. The black colorant is believed to improve the EMF performance of the cable, and preferably is present at about 0.15 wt-%, or in a range of at least 0.05 wt-% up to about 0.5 wt-%.

The preferred method of manufacturing the invented cable includes making the wires according to the specifications disclosed herein, twisting the wires in the preferred twist, and positioning two pair parallel to each other and spaced apart a constant distance, preferably a minimum of 0.05 inches apart, and preferably in the range of about 0.05 - 0.08 inches apart at their centers. Cables with lesser distances between the centers of the twisted pairs, for example, 0.02 - 0.03 inches apart at their centers, have been made and have acceptable performance, but not optimum performance. The preferred insulation mixture is melted and extruded around the twisted pairs of wire, preferably a continuous operation. To do this, the preferred two pair may be run through an extrusion die with the melted insulation material being extruded through the die completely around the spaced pair to encase the pair. After extrusion, the insulation is cooled. This process is conducted with very strict control to produce a cable with very tight tolerances in all parameters, particularly including very flat outer surfaces.

The resulting cable may have dimensions preferably as follows (see reference letters in Figure C):

Thickness from front side to back side (T):

less than or equal to 0.073 inches, preferably about 0.04 inches

Width from edge to edge (W):

0.13 - 0.17 inches, preferably about 0.016 inches

Distance between twisted pairs in cable, measured from center to center:

0.05 - 0.08 inches, preferably 0.05 inches

Distance between inner surfaces of twisted pair (C):

about 0.0275 - 0.06 inches (preferably about 0.0275 inches), depending on distance between twisted pairs at centers and the relative twist positions of the two pairs

Distance from twisted pair to surface of cable:

A: about 0.004 - 0.005 inches

A': about 0.012 inches

Distance from twisted pair to edge of cable:

B: about 0.025 - 0.04 inches

B': about 0.032 - 0.048 inches

As suggested by Figure 5C and the above examples of dimensions, the various dimensions, that is amounts of insulation 40 beside, above, below, and between the twisted pairs and the outer surfaces of the cable depend on the outer dimensions of the cable, the gauge of the wire, the placement of the wires inside the cable, and the position at which you measure along the length of the twisted wires (twist position). After manufacture, the resulting cable is checked for quality, including tests for undesirable bubbles in the insulation and check for electrical continuity.

Cables made by these methods were tested to prove that the appropriate attenuation, impedance, and cross-talk performance was achieved with the surprisingly flexible and compact cable. Specifications for Cat 5 applications were targeted, as required by TIA specification 568. The test results are shown in Figures 7A-C, in which megahertz is the X axis, and decibels is the Y axis, shown by convention without any negative sign on the y axis. A cable made according to one embodiment of the invention (0.073 inch thickness, 26 gauge stranded wire, 7 strand, 0.0085 inch thick Teflon coating around each wire of the two twisted pair, PeBax™ insulation extruded around the twisted pair) was tested by using wire scopes to measure attenuation (loss of signal over the length of the cable) and "local next" and "remote next" EMF (local cross-talk between pairs at the originating end of the cable and remote cross-talk between pairs at the far end of the cable). This data is plotted in Figure 7A, along with the specifications for Cat 5 use which are labeled as "limits." From the data, one may see that attenuation is well below the maximum specification, substantially at ≤ 2 dB signal loss. Local Next (labeled as "local cross-talk") and Remote Next (labeled as "remote cross-talk") are significantly better than the limits, that is, at least 10 - 15 greater dB "below" the specification (limits) for Cat 5 applications. In addition, the

resistance of the cable made according to the present invention has been measured at about 61 milliohms per foot, which is well within the appropriate range.

Another embodiment of the invented cable (0.05 inch thickness, 32 AWG oxygen-free copper stranded wire, 0.005 inch thick Teflon coating around each wire of the two twisted pair; in PeBax™ insulation extruded around the twisted pair) was tested, and gave the resulting performance as shown in Figure 7B and 7C. As may be seen by the data in Figure 7B and 7C, a 7 foot length of the thin, compact and flat cable according to the invention meets and greatly exceeds Cat 5 specifications. An especially-preferred cable, that is, a cable 0.04 inches thick, with 30 gauge tinsel wire surrounded with fused FEP-coated with 0.003 inches thick, and with outer flat insulation of extruded PeBax™ is expected to be so excellent that it is appropriate, or close to being appropriate, for Category 6 applications.

Cable according to the invention was installed in a cable retractor such as is described in the prior patents of the owner of this invention. At least 3 feet of the invented cable fit inside a retractor of approximately 2 inches in diameter. The cable was tested in a repeated extension/retraction test and underwent thousands of extensions and retractions without failure of the cable, that is, without any breakage of the wires, strands, or insulator.

A more preferred retractor that efficiently retracts longer cables may be made by slightly increasing the diameter of the retractor to about 2.5 - 3 inches and by including a slightly stronger spring and, optionally, a stronger ratchet mechanism. Such a retractor for cooperation with the invented cable is illustrated by the retractor in Figures 8-10, and is effective for lengths of the invented Cat 5 cable of up to about 25 feet. This retractor is preferably 2.85 inches in diameter, is of heavy duty construction and features a heavier spring than conventional cable retractors. As illustrated in the exploded view of Figure 8, the casing of the retractor 200 includes a first half 201 and a second half 202, a rachet mechanism 204 for optionally locking the cord in a particular extended position, a plate 206 with an aperture 208 through which cable extends continuously, and a space for the spring 209, a space 210 between the rachet mechanism and the plate 206 for the "stationary" portion of the cable (winds and unwinds inside the space 210 as the extendible cable is extended and retracted, but does not pull out from the retractor), and a space 212 between the first casing and the plate 206 for receiving the extendible portion of the cable. Figure 9 illustrates a surface of the plate 206, which is the underside of the plate as portrayed in Figure 8. This plate includes the axle 207, aperture 208 through which the cable

passes, and a generally circular ridge 220 which includes a passage 222 through the ridge for allowing the cable to pass to the outside of the ridge to wind around the outer surface 224 of the ridge in a plurality of windings. As illustrated in Figure 10, the cable passes through the aperture 208, through the passage 222, and around the ridge 220 to form the windings 230. When the cable is "fully extended," that is, preferably to the extent of the spring's motion, there would be still be one or more windings around the ridge to prevent tension on the cable at the point the cable passes through the aperture 208. The cable extends out from the windings generally radially outward from the outer surface 224 of the ridge to exit the casing at port 226.

The inventor envisions that embodiment of the invented cable will be used with RG45 connectors having 8 contacts for either two or four twisted pairs for special applications such as ISDN applications.

Therefore, the invented cable and the resultant retractor are surprisingly effective in terms of convenience, performance, and durability. The combined effect of the several parameters of the invented cable result in a surprisingly flexible cable that performs well in high speed data applications. These parameters include the thinness of gauge of the stranded wire, or the thinness of gauge of the tinsel wire, composition of the wire, the extremely thin and strippable insulation around each wire, and a flexible, cross-talk-resistant, and very uniform outer encasement of insulation around both pair of twisted wire. While thinness of wire, coating, and insulation is generally desirable for forming a compact cable, the thinness needed for a cable in a retractor would be expected to result in low quality performance in a typical Cat 5 application. Contrary to this expectation, the inventor has surprisingly attained excellent performance with his combination of materials, dimensions, and arrangements.

Although this invention has been described above with reference to particular means, materials and embodiments, it is to be understood that the invention is not limited to these disclosed particulars, but extends instead to all equivalents within the broad scope of the invention.

Claims

I claim:

1. A retractor system for Category 5 computer cable comprising:

a retractor comprising a housing with an interior space, at least one cable port and a spring-biased winding mechanism,

a flat electronic transmission cable of 7 - 25 feet in length wound inside the interior space and having an end exiting the cable port, the cable exhibiting attenuation of less than about 5 dB over the range of 1-100 MHZ range and exhibiting cross-talk at least 10 dB better than the cross-talk TIA-568 standard limit in the range of 1- 100mHz.;

wherein the cable has a thickness, a width, and a length, the thickness being less than about ½ the width of the cable; and

wherein the cable is extendible out from the retractor when the end is pulled out from the housing; and wherein the cable is retractable into the housing by the spring-biased mechanism.

2. The retractor system as in Claim 1, wherein the cable thickness is less than about 1/4 the width of the cable.

3. The retractor system as in Claim 2, wherein the retractor housing has an outer diameter of less than about 3 inches.

4. A flat electronic transmission cable meeting Category 5 specifications comprising:

a plurality of twisted pairs of two stranded wires, each wire comprising a plurality of conductive strands, and each wire being 26-32 American Wire Gauge;

a coating of low dielectric material around each wire of the twisted pairs, the coating being between 0.002 - .0085 inches thick; and

insulation surrounding the plurality of twisted pairs;

wherein the plurality of twisted pairs are parallel and spaced apart from each other in the insulation; and

wherein the cable has a thickness, a width, and a length, the thickness being less than about ½ the width of the cable.

5. The cable of Claim 4, where the coating is 0.002-0.003 inches thick, and the cable thickness is less than about 1/4 the width of the cable.

6. The cable of Claim 4, wherein the coating is fluorine-ethylene-propylene.

7. The cable of Claim 4, wherein the conductive strands are oxygen-free copper.

8. The cable of Claim 4, wherein the conductive strands are cadmium-copper.

9. The cable of Claim 4, wherein the conductive strands are tin-copper.

10. The cable of Claim 4, wherein the insulation is block-polyamide.

11. The cable of Claim 4, wherein the insulation is selected from the group consisting of: PVC, polyester-elastomers, polyolefins, thermoplastic polyester resin, and ionomer resin

12. The cable of Claim 4, wherein each of the stranded wires comprises a central core strand and a plurality of strands surrounding the core, wherein the central core strand is steel.

13. The cable of Claim 4, wherein each wire comprises 19 conductive strands, each strand being about 40 American Wire Gauge.

14. A flat electronic transmission cable meeting Category 5 specifications comprising:

a plurality of twisted pairs of two tinsel wires, each wire comprising a core and a plurality of conductive tinsel ribbons wrapped around the core, each tinsel wire being in the range of 26-32 American Wire Gauge;

a coating of low dielectric material around each wire of the twisted pairs, the coating being between 0.002 - .0085 inches thick; and

insulation surrounding the plurality of twisted pairs;

wherein the plurality of twisted pairs are parallel and spaced apart from each other in the insulation; and

wherein the cable has a thickness, a width, and a length, the thickness being less than about ½ the width of the cable.

15. The cable of Claim 14, where the coating is 0.002-0.003 inches thick, and the cable thickness is less than about 1/4 the width of the cable.

16. The cable of Claim 14, wherein the coating is fluorine-ethylene-propylene.

17. The cable of Claim 14, wherein the conductive ribbons are cadmium-copper.

18. The cable of Claim 14, wherein the insulation is a block-polyamide.

19. The cable of Claim 14, wherein the insulation is selected from the group consisting of: PVC, polyester-elastomers, polyolefins, thermoplastic polyester resin, and ionomer resin.

20. A retractor system for unwinding and retracting cable meeting Category 5 specifications, the retractor system comprising:

a retractor comprising a housing with an interior space, at least one cable port and a spring-biased winding mechanism,

a flat electronic transmission cable wound inside the interior space and having an end exiting the cable port, the cable meeting Category 5 specifications, the cable further comprising:

a plurality of twisted pairs of two stranded wires, each wire comprising a plurality of conductive strands, and each wire being 26-32 American Wire Gauge;

a coating of low dielectric material around each wire of the twisted pairs, the coating being between 0.002 - .0085 inches thick; and

insulation surrounding the plurality of twisted pairs;

wherein the plurality of twisted pairs are parallel and spaced apart from each other in the insulation; and

wherein the cable has a thickness, a width, and a length, the thickness being less than about ½ the width of the cable; and

wherein the cable is extendible out from the retractor when the end is pulled out from the housing; and wherein the cable is retractable into the housing by the spring-biased mechanism.

21. The retractor system as in Claim 19, wherein the cable is less than or equal to 25 feet long and the retractor is less than or equal to 3 inches in diameter.

22. The retractor system of Claim 19, where the coating is 0.002-0.003 inches thick, and the cable thickness is less than about 1/4 the width of the cable, and the retractor is less than or equal to 3 inches in diameter.

23. The retractor system of Claim 20, wherein the coating is fluorine-ethylene-propylene.

24. The retractor system of Claim 20, wherein the conductive strands are oxygen-free copper.

25. The retractor system of Claim 20, wherein the conductive strands are cadmium-copper.

26. The retractor system of Claim 20, wherein the conductive strands are tin-copper.

27. The retractor system of Claim 20, wherein the insulation is block-polyamide.

28. The retractor system of Claim 20, wherein the insulation is selected from the group consisting of: PVC, polyester-elastomers, polyolefins, thermoplastic polyester resin, and ionomer resin.

29. The retractor system of Claim 20, wherein each of the stranded wires comprises a central core strand and a plurality of strands surrounding the core, wherein the central core strand is steel.

30. The retractor system of Claim 20, wherein each wire comprises 19 conductive strands, each strand being about 40 American Wire Gauge.

31. The retractor system of Claim 20, wherein the housing further comprises a second cable port, the cable further has another end extending the second cable port, and the cable is extendible out from the cable port and second cable port when the ends are pulled out from the housing; and wherein the cable is retractable into the housing through the cable port and second cable port by the spring-biased mechanism.

///
///
///
///
///
///
///
///
///
///

32. A retractor system for unwinding and retracting cable meeting Category 5 specifications, the retractor system comprising:

a retractor comprising a housing with an interior space, at least one cable port and a spring-biased winding mechanism,

a flat electronic transmission cable wound inside the interior space and having an end exiting the cable port, the cable meeting Category 5 specifications, the cable further comprising:

a plurality of twisted pairs of two tinsel wires, each wire comprising a core and a plurality of conductive tinsel ribbons wrapped around the core, each tinsel wire being in the range of 26-32 American Wire Gauge;

a coating of low dielectric material around each wire of the twisted pairs, the coating being between 0.002 - .0085 inches thick; and

insulation surrounding the plurality of twisted pairs;

wherein the plurality of twisted pairs are parallel and spaced apart from each other in the insulation; and

wherein the cable has a thickness, a width, and a length, the thickness being less than about ½ the width of the cable

wherein the cable is extendible out from the retractor when the end is pulled out from the housing; and wherein the cable is retractable into the housing by the spring-biased mechanism.

33. The retractor system as in Claim 32, wherein the cable is less than or equal to 25 feet long and the retractor is less than or equal to 3 inches in diameter.

34. The retractor system of Claim 32, where the coating is 0.002-0.003 inches thick, and the cable thickness is less than about 1/4 the width of the cable, and the retractor is less than or equal to 3 inches in diameter.

35. The retractor system of Claim 32, wherein the coating is fluorine-ethylene-propylene.

36. The retractor system of Claim 32, wherein the conductive ribbons are cadmium-copper.

37. The retractor system of Claim 32, wherein the insulation is block-polyamide.

38. The retractor system of Claim 32, wherein the insulation is selected from the group consisting of: PVC, polyester-elastomers, polyolefins, thermoplastic polyester resin, and ionomer resin.

39. The retractor system of Claim 32, wherein the housing further comprises a second cable port, the cable further has another end extending the second cable port, and the cable is extendible out from the cable port and second cable port when the ends are pulled out from the housing; and wherein the cable is retractable into the housing through the cable port and second cable port by the spring-biased mechanism.

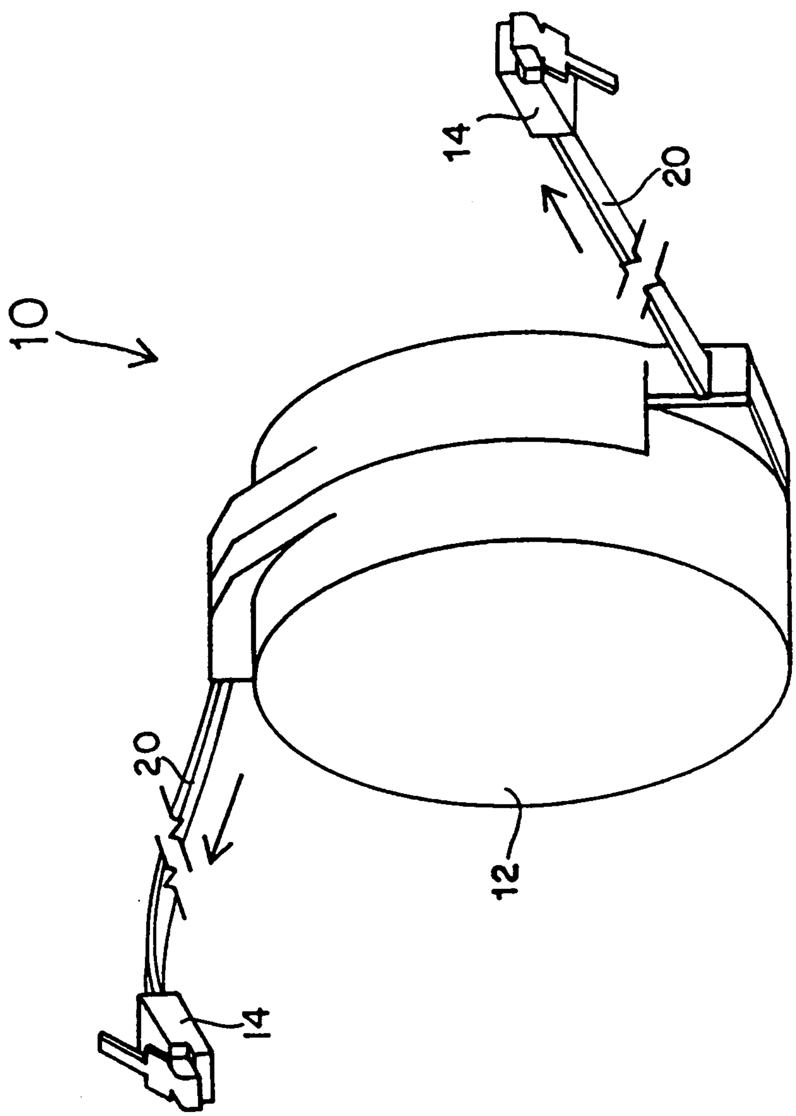


FIG. 1A

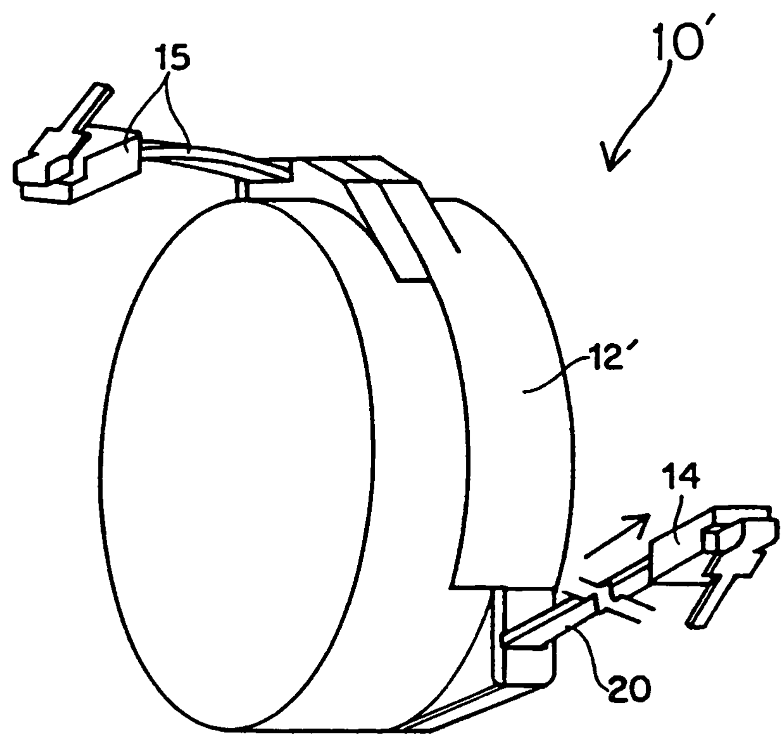


FIG. 1B

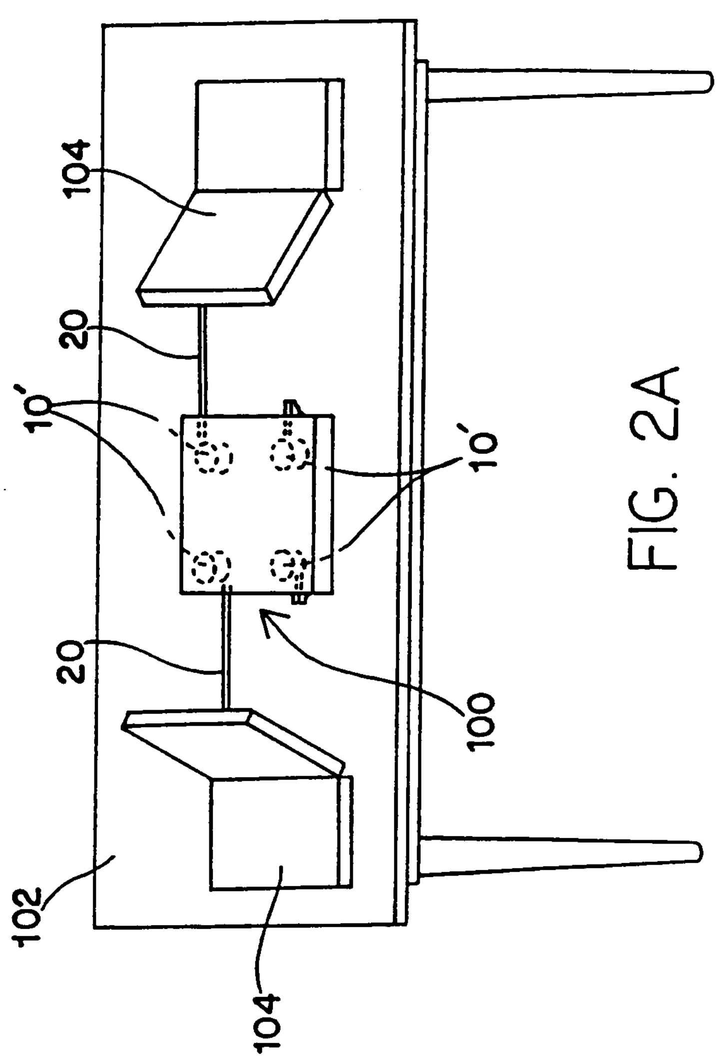


FIG. 2A

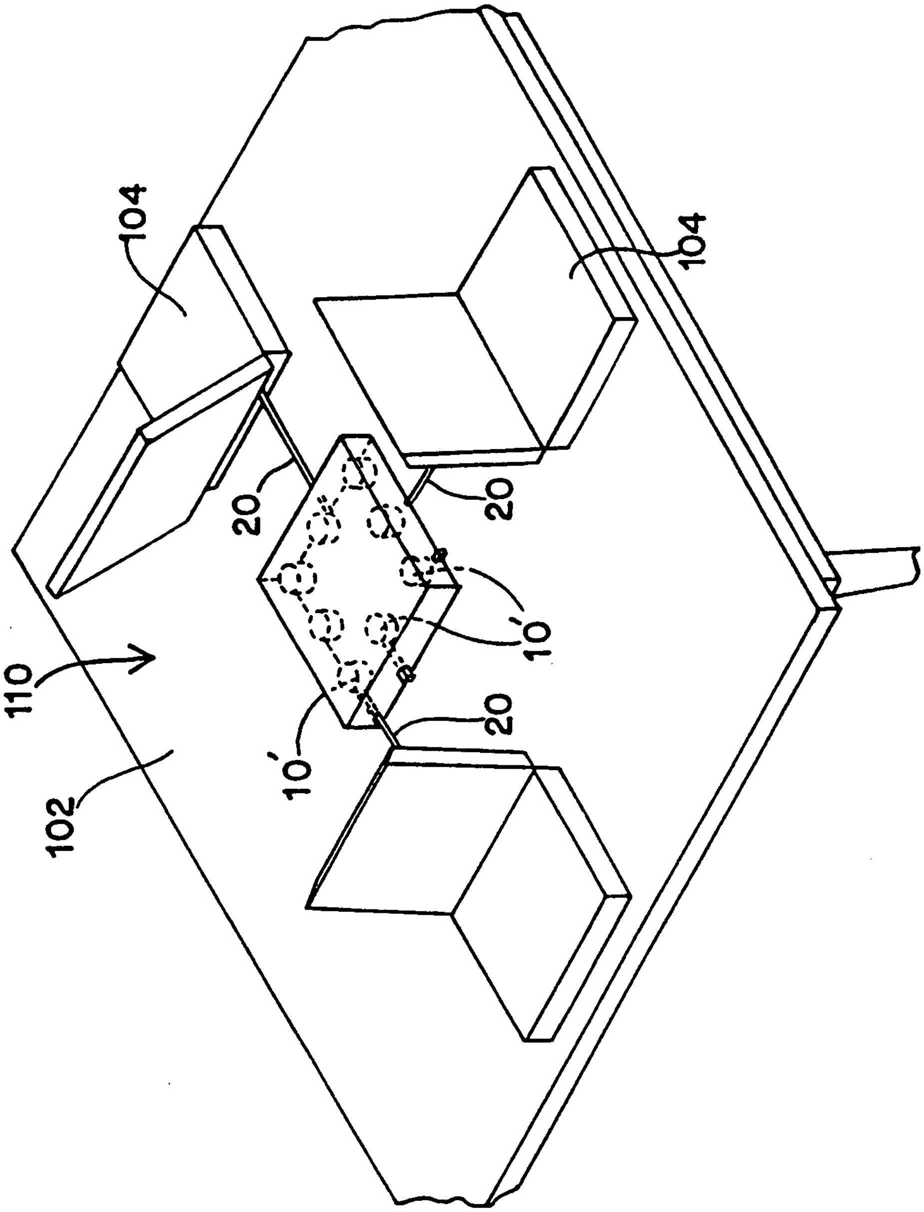


FIG. 2B

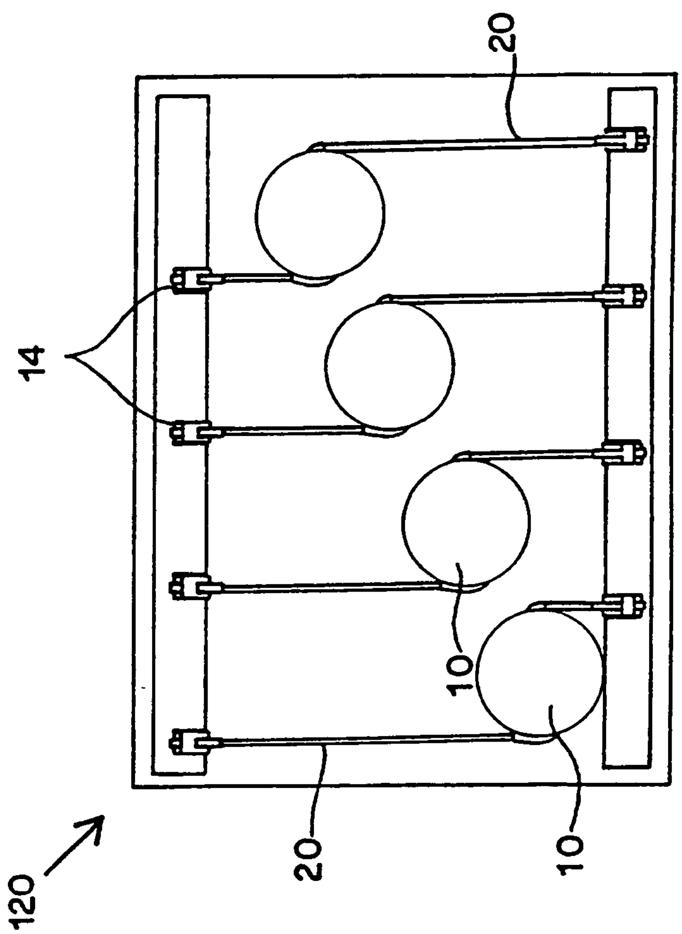


FIG. 2C

6/19

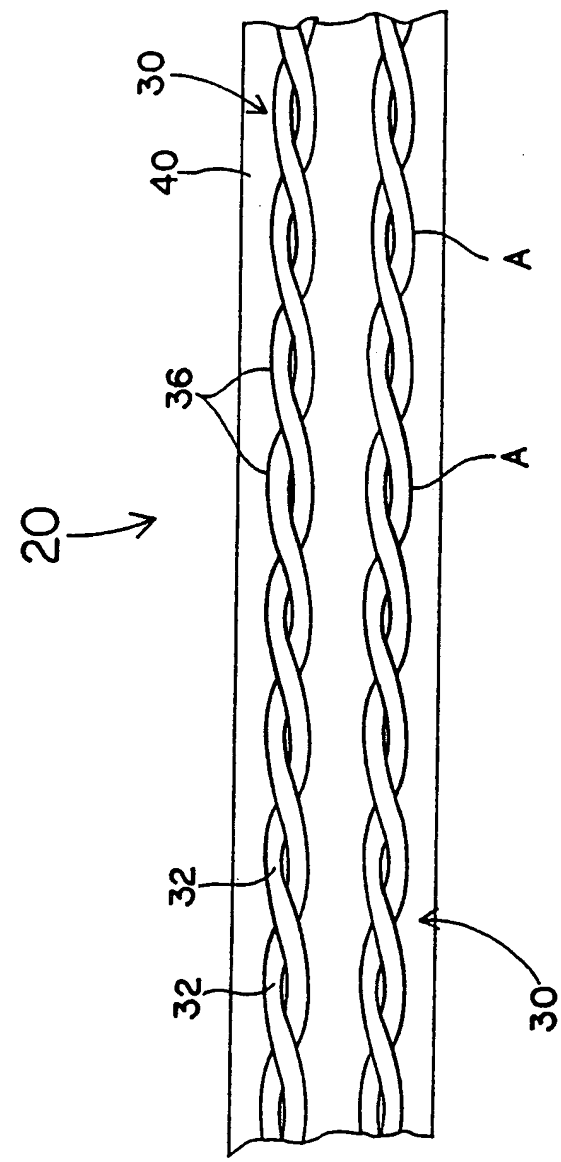


FIG. 3A

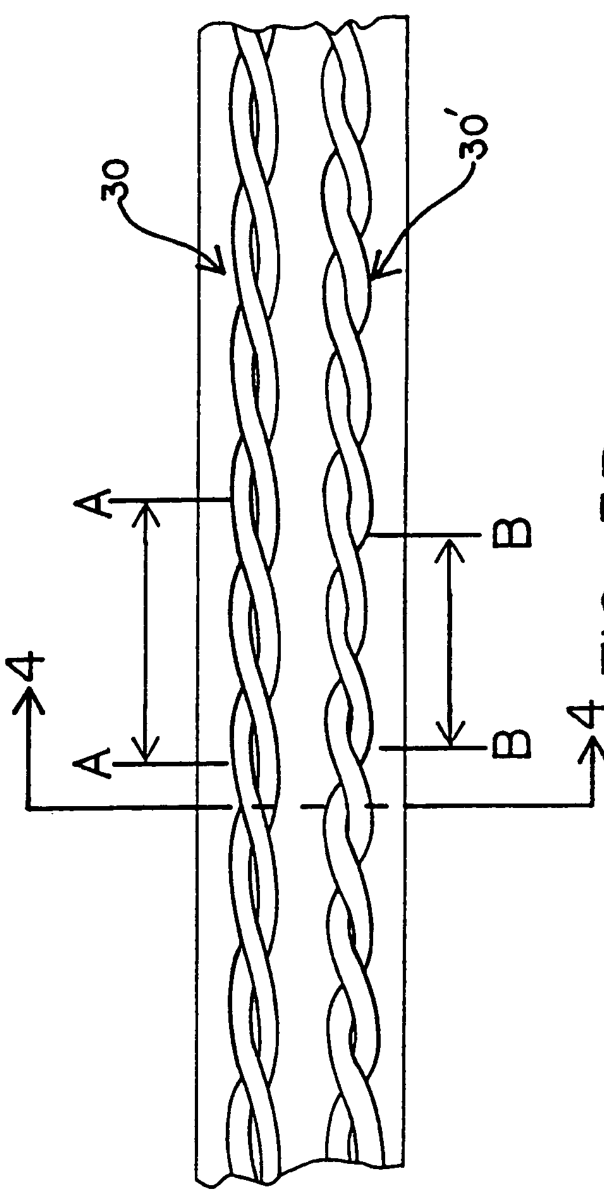


FIG. 3B

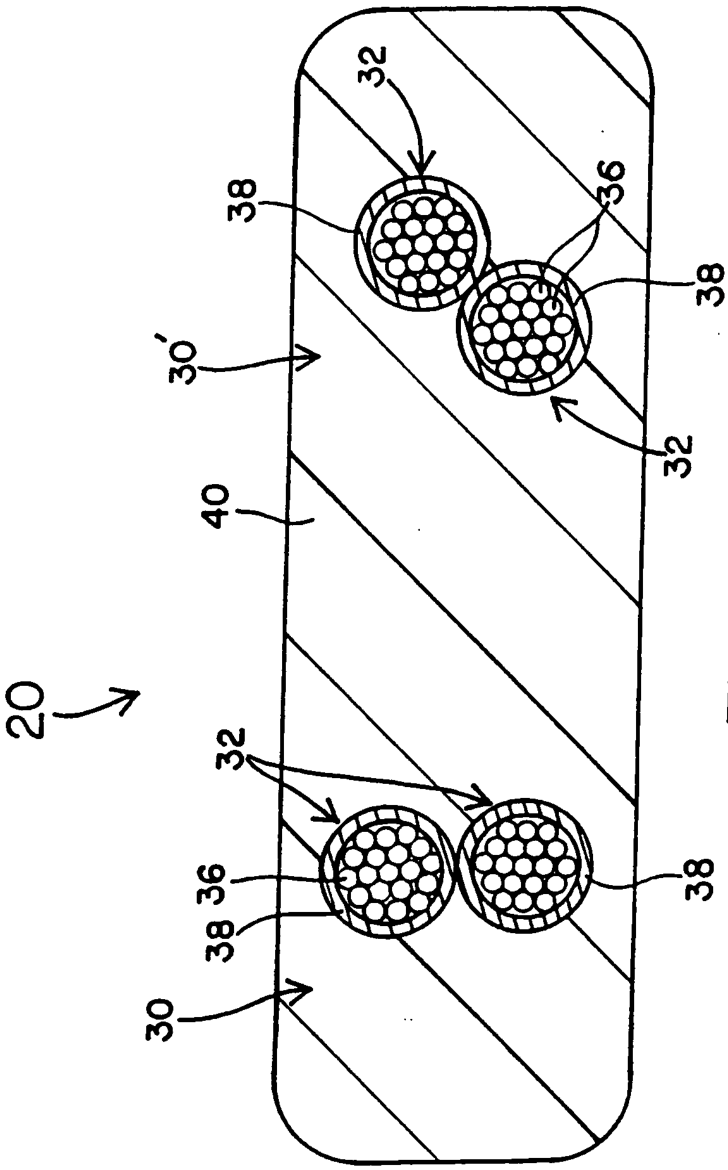


FIG. 4

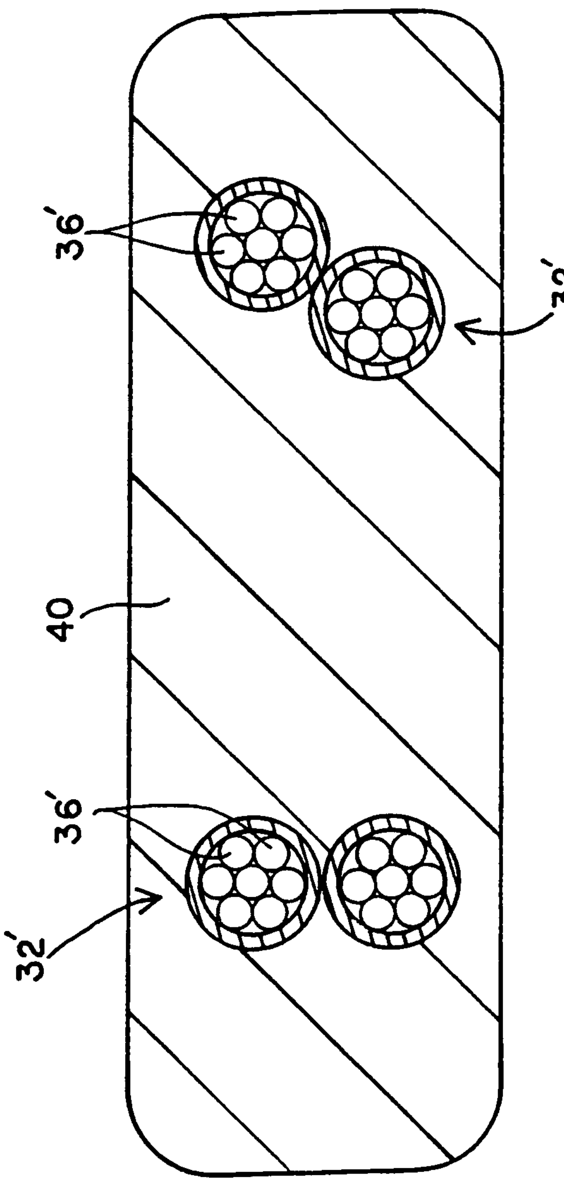


FIG. 5A

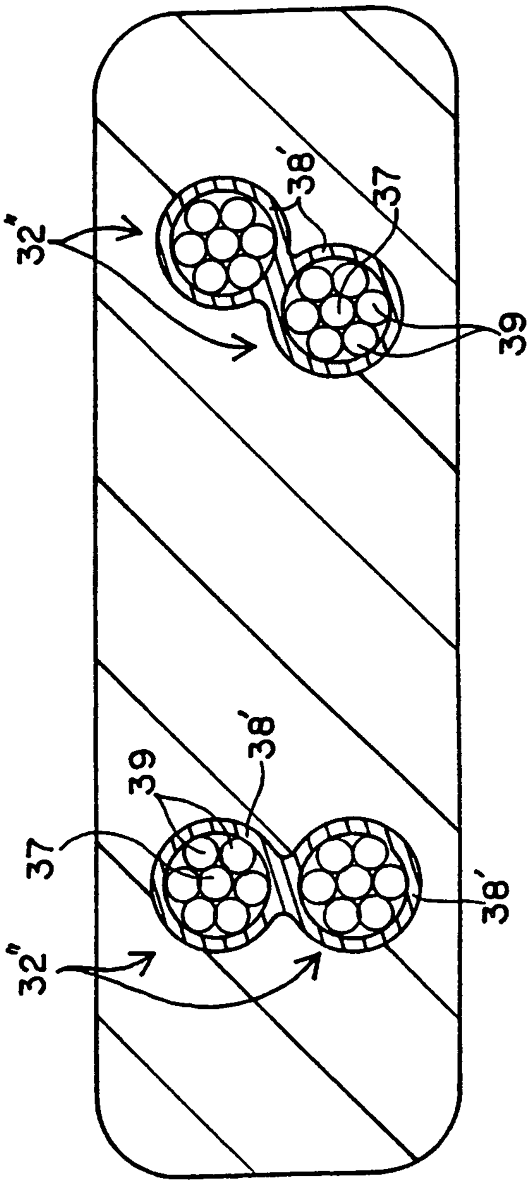


FIG. 5B

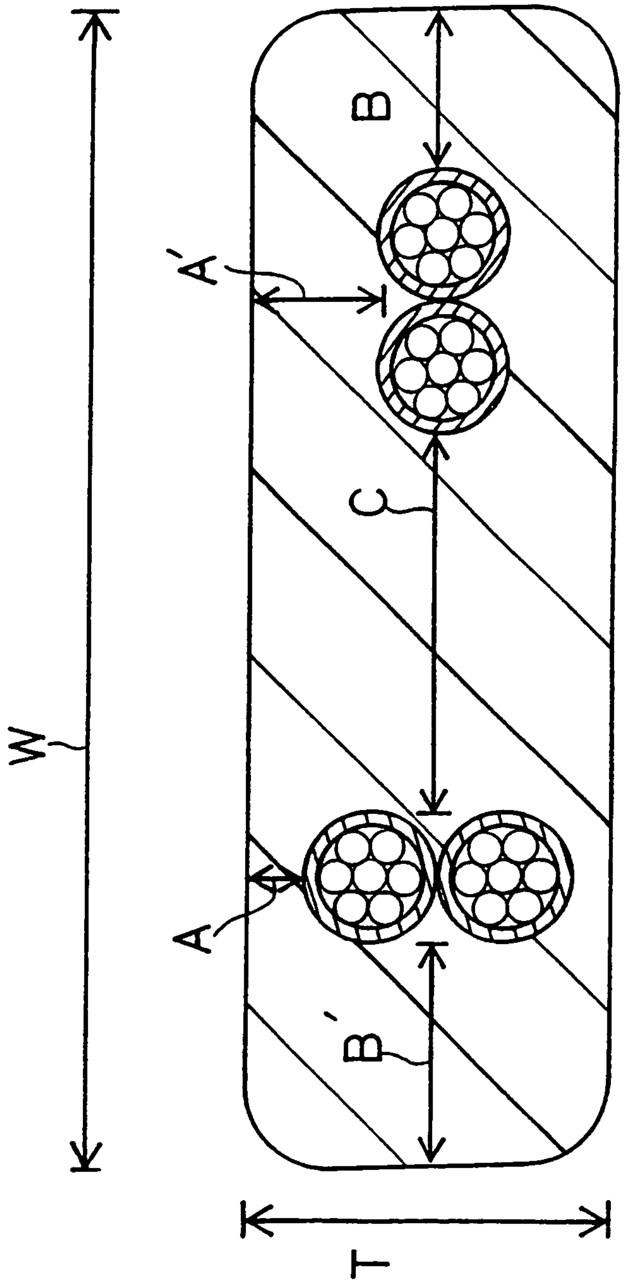


FIG. 5C

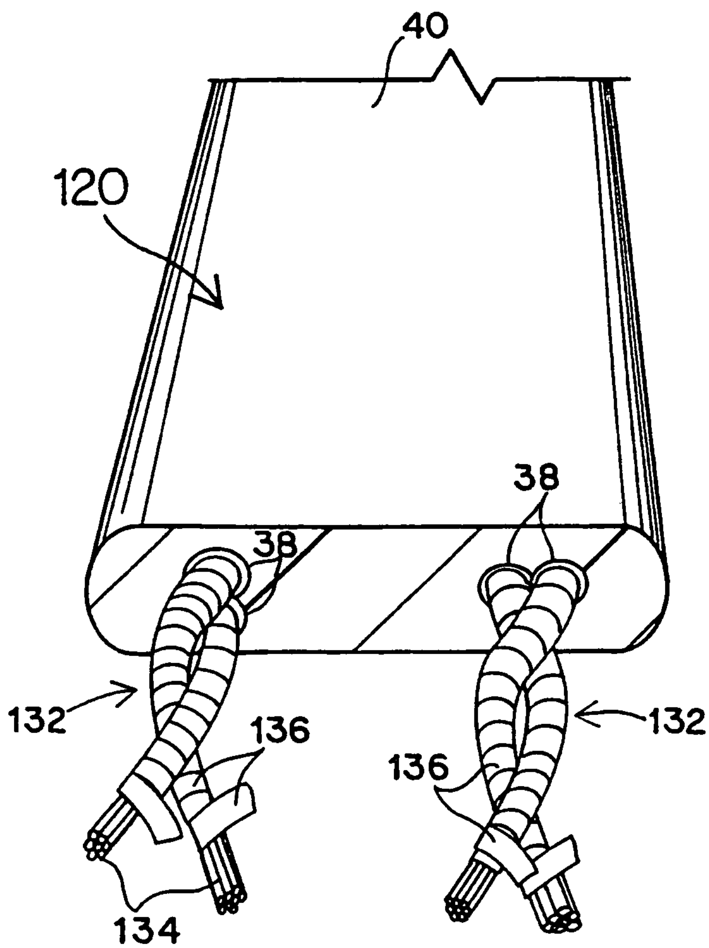


FIG. 6

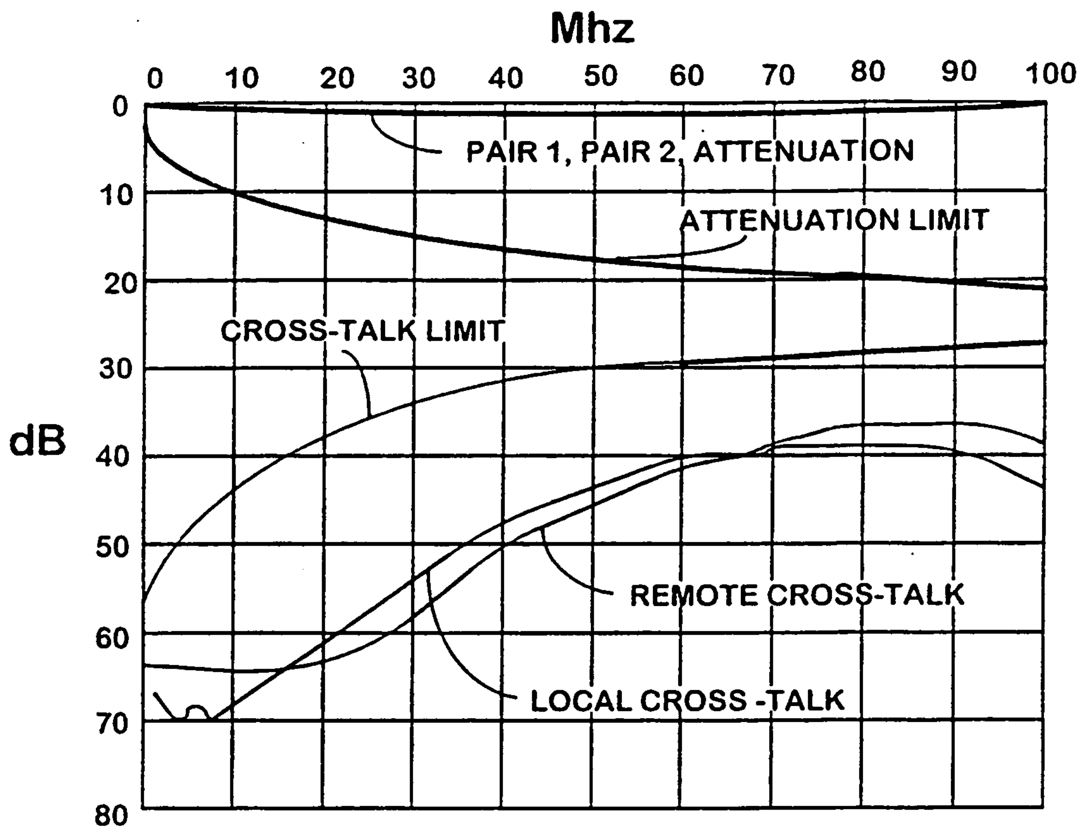

Mhz
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60
70
80
dB
PAIR 1, PAIR 2, ATTENUATION
ATTENUATION LIMIT
CROSS-TALK LIMIT
REMOTE CROSS-TALK
LOCAL CROSS -TALK

FIG. 7A

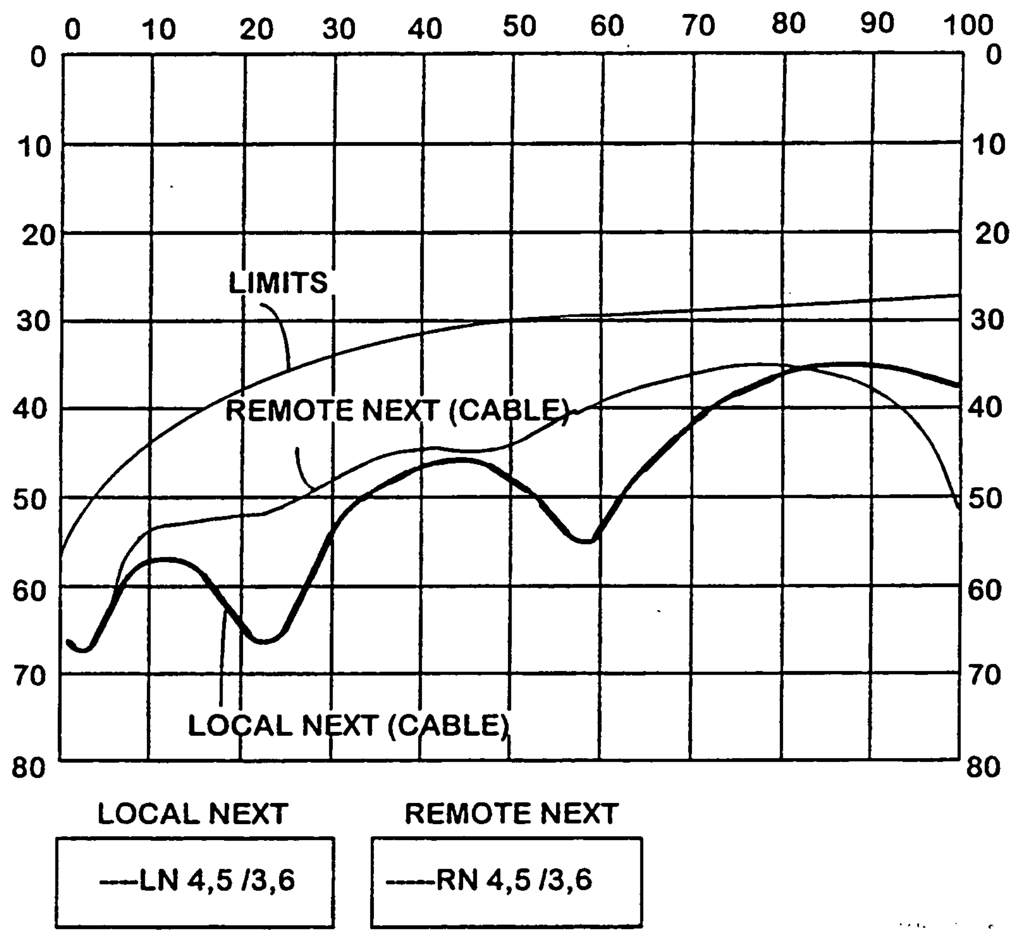

0
10
20
30
40
50
60
70
80
90
100
LIMITS
REMOTE NEXT (CABLE)
LOCAL NEXT (CABLE)
LOCAL NEXT
—LN 4,5 /3,6
REMOTE NEXT
—RN 4,5 /3,6

FIG. 7B

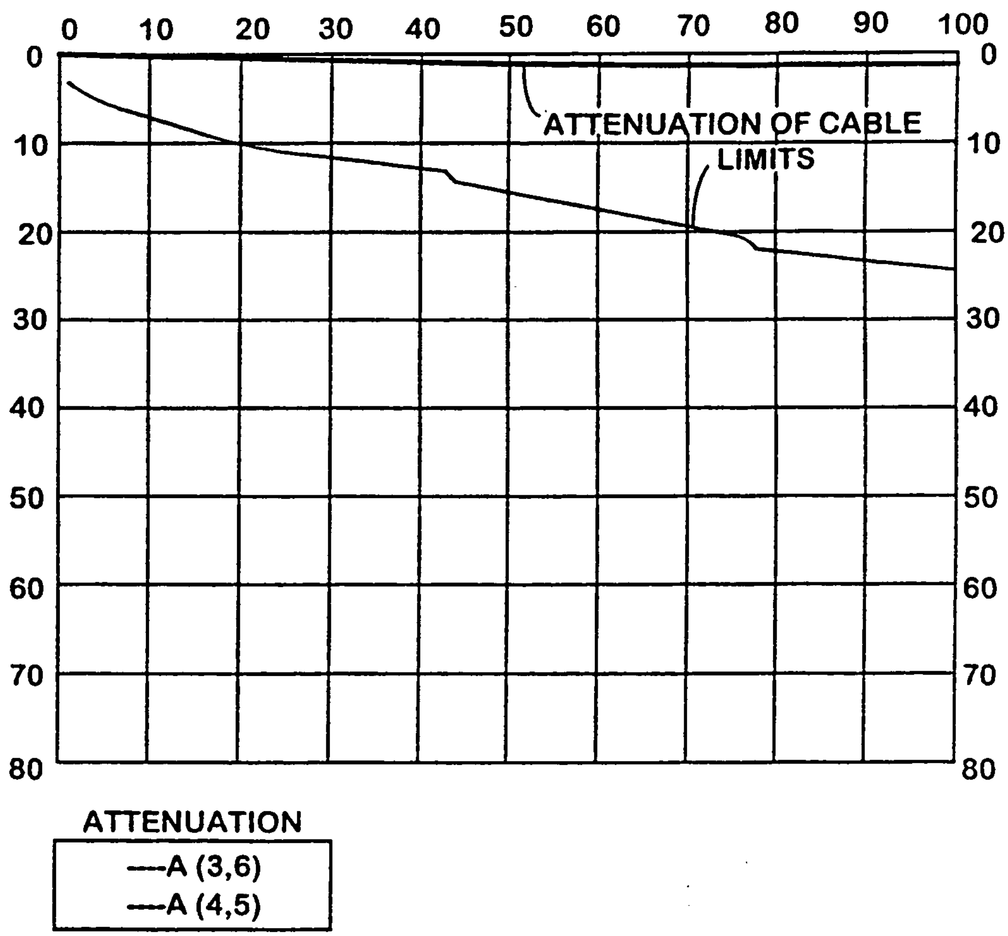

0
10
20
30
40
50
60
70
80
90
100
ATTENUATION OF CABLE
LIMITS
ATTENUATION
—A (3,6)
—A (4,5)

FIG. 7C

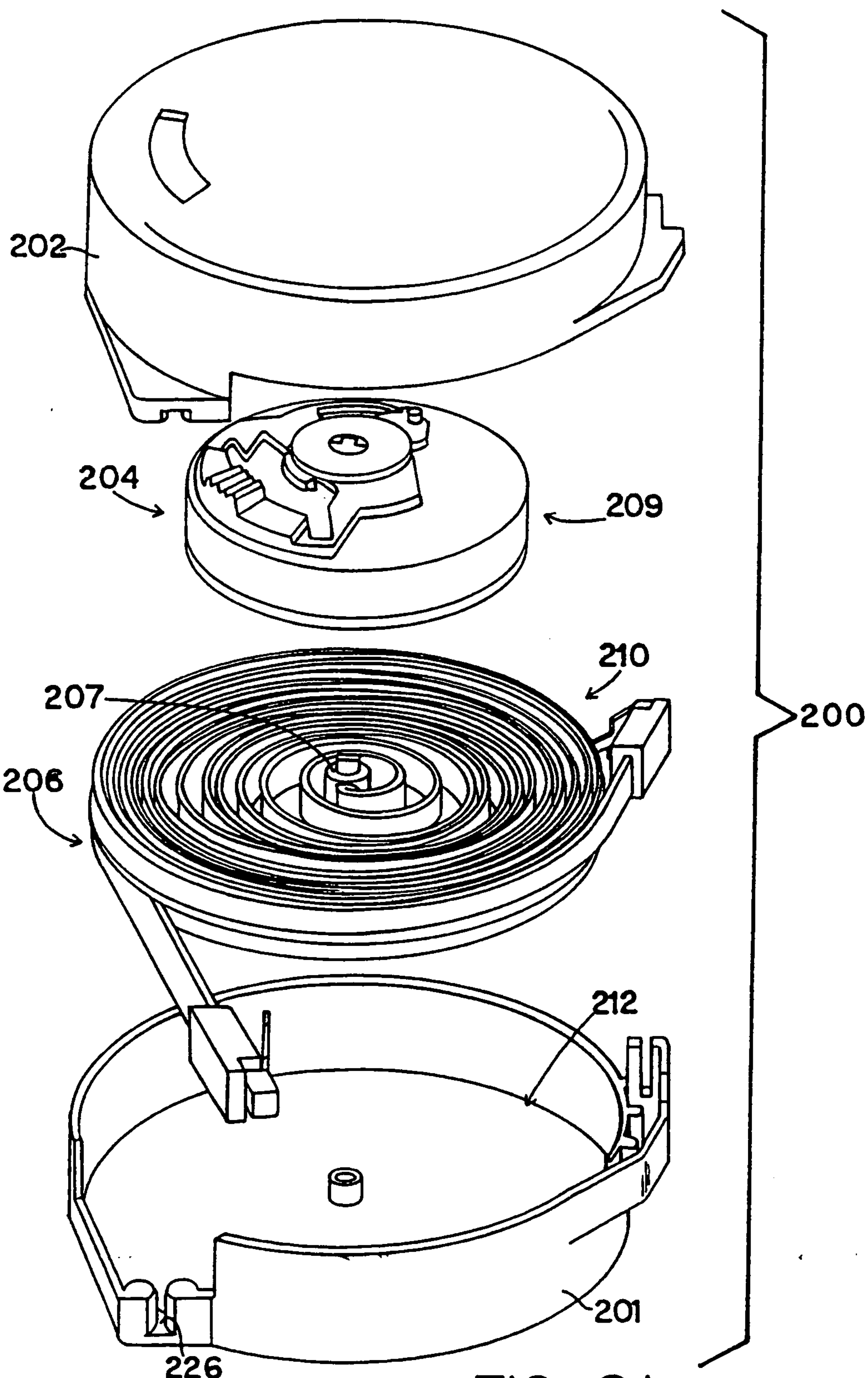


FIG. 8A

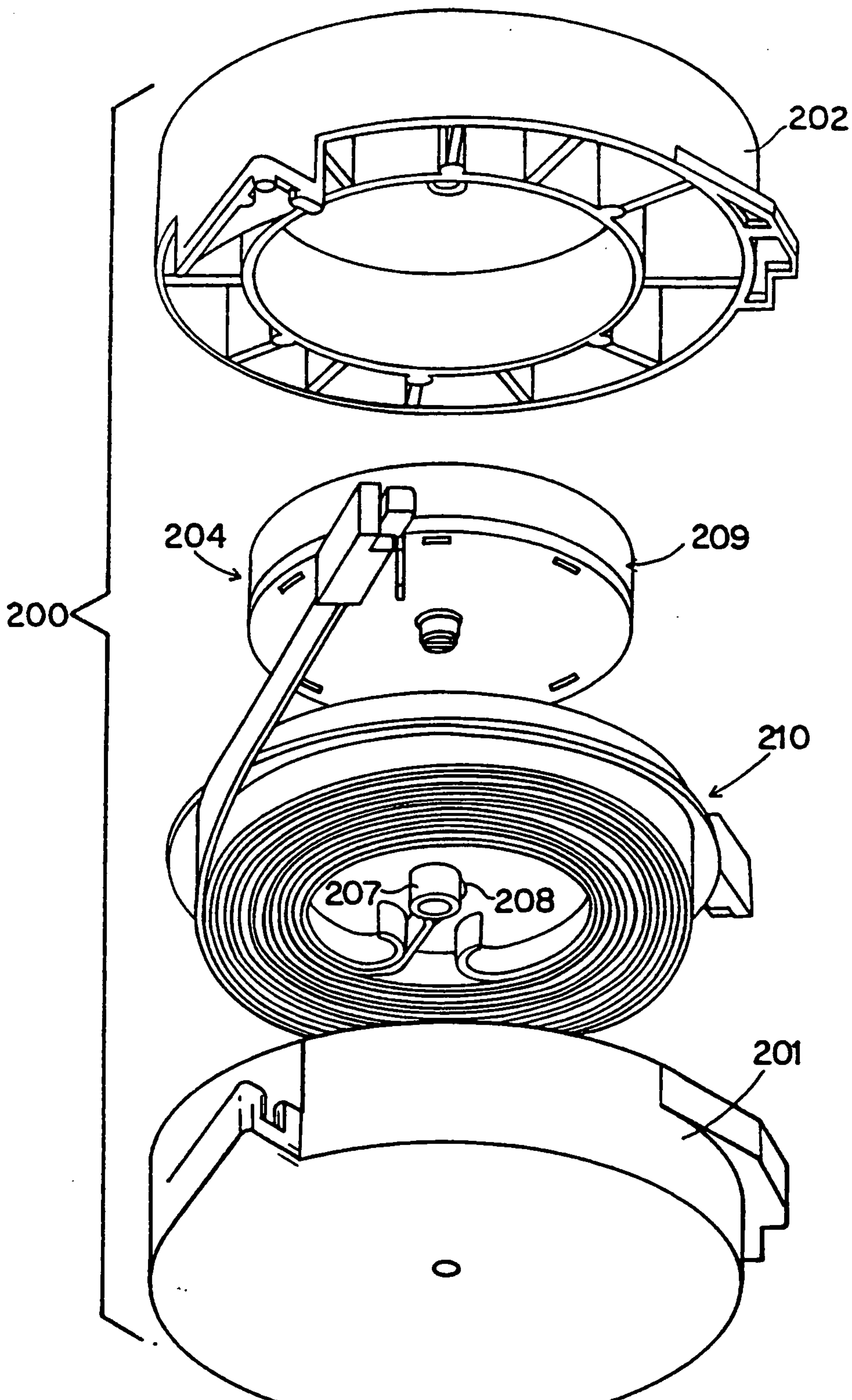


FIG. 8B

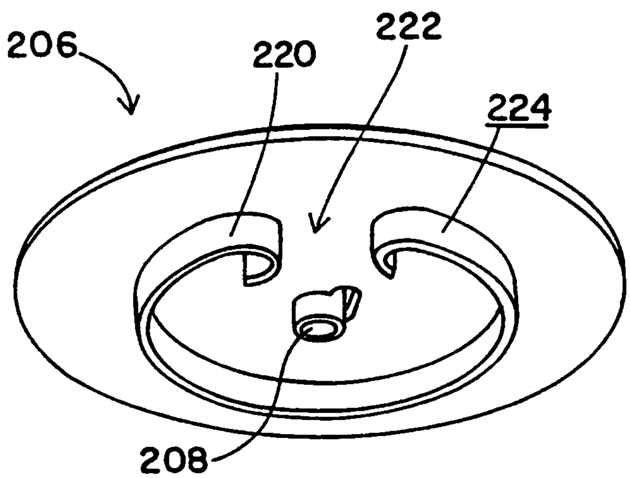


FIG. 9

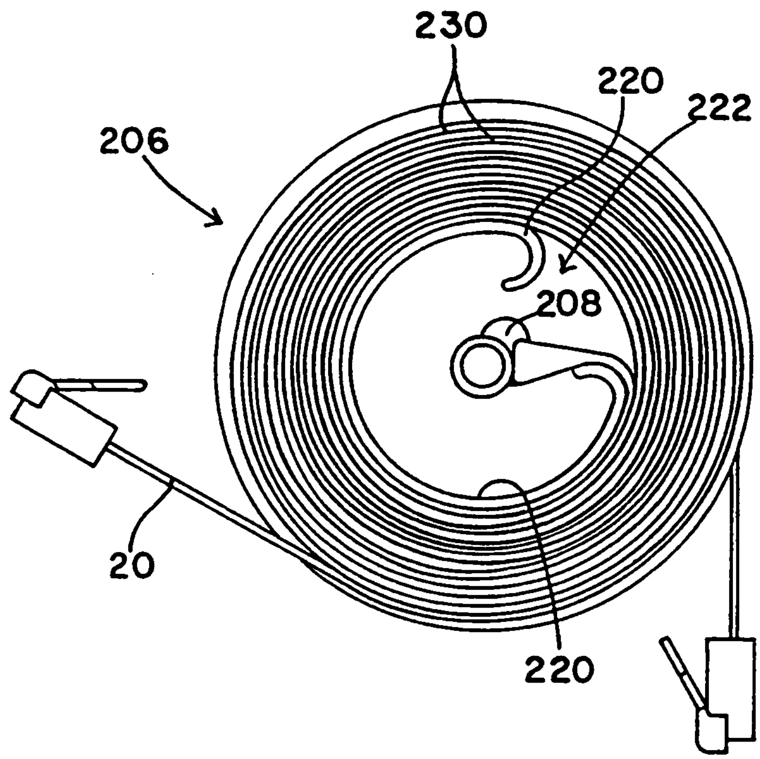


FIG. 10

INTERNATIONAL SEARCH REPORT1

International Application No
PCT/US 00/11446

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02G11/02 H01B7/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H02G H01B H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 718 310 A (GALLO BRUCE) 17 February 1998 (1998-02-17) column 2, line 38 -column 3, line 58; figures 1-7	1,3,20, 32
X	US 5 468 159 A (BRODSKY WILLIAM L ET AL) 21 November 1995 (1995-11-21) claims 1-8; figures 1-8	1,3,20, 32,39
A	US 5 590 749 A (WAGNER RONALD D ET AL) 7 January 1997 (1997-01-07) column 7, line 6 -column 10, line 16; figures 1-7	1,3,20, 32
A	US 5 797 558 A (PETERSON ET AL) 25 August 1998 (1998-08-25) cited in the application abstract; claim 1; figures 1-10	1,3,20, 32

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 August 2000	01/09/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lomm 1, A

1

International Application No
PCT/US 00/11446

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 646 987 A (PETERSON EDWIN R) 3 March 1987 (1987-03-03) cited in the application column 1, line 63 -column 2, line 66; figures 1-5	1,3,20, 32
A	US 5 516 986 A (PETERSON EDWIN P ET AL) 14 May 1996 (1996-05-14) cited in the application column 3, line 8 -column 4, line 36; figures 1-5	1,2,4-6, 10,11, 14-16, 18, 20-23, 27-29, 32-39
A	US 5 399 813 A (MCNEILL DAVID B ET AL) 21 March 1995 (1995-03-21) the whole document	1,2,4,5, 11,14, 15,19, 20,32
A	US 5 814 768 A (HAYES TRENT ET AL) 29 September 1998 (1998-09-29) the whole document	1,2,4,5, 11,14, 15,19, 20,32
A	US 5 354 954 A (PETERSON EDWIN R) 11 October 1994 (1994-10-11) cited in the application column 3, line 24 -column 4, line 49; figures 1-6	1,2,4-6, 10,11, 14-16, 18, 20-23, 27-29, 32-39
A	US 5 821 467 A (O'BRIEN DOUGLAS D ET AL) 13 October 1998 (1998-10-13) column 2, line 34 -column 5, line 65; figures 1-3	1,2,4,5, 14,15, 20,32
A	US 3 833 755 A (SOELBERG R) 3 September 1974 (1974-09-03)	
A	US 4 404 424 A (KING WILLIAM A ET AL) 13 September 1983 (1983-09-13)	

1

INTERNATIONAL SEARCH REPORT1

Information on patent family members

Int tional Application No
PCT/US 00/11446

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5718310 A	17-02-1998	CA 2208820 A	19-02-1998
		CN 1175544 A	11-03-1998
		WO 9808285 A	26-02-1998
US 5468159 A	21-11-1995	EP 0644557 A	22-03-1995
		JP 2561803 B	11-12-1996
		JP 6309941 A	04-11-1994
US 5590749 A	07-01-1997	US 5819893 A	13-10-1998
US 5797558 A	25-08-1998	US 5655726 A	12-08-1997
US 4646987 A	03-03-1987	NONE	
US 5516986 A	14-05-1996	NONE	
US 5399813 A	21-03-1995	CA 2122420 A	25-12-1994
		IT 1270136 B	29-04-1997
		TR 28499 A	02-09-1996
US 5814768 A	29-09-1998	CA 2206022 A	03-12-1997
US 5354954 A	11-10-1994	AU 7552294 A	28-02-1995
		WO 9504357 A	09-02-1995
US 5821467 A	13-10-1998	AU 4489497 A	02-04-1998
		CN 1236477 A	24-11-1999
		EP 0953196 A	03-11-1999
		GB 2332299 A	16-06-1999
		WO 9811563 A	19-03-1998
US 3833755 A	03-09-1974	AR 203046 A	08-08-1975
		AU 6718774 A	02-10-1975
		CA 1001730 A	14-12-1976
		DE 2418000 A	03-07-1975
		FR 2241127 A	14-03-1975
		GB 1462671 A	26-01-1977
		GB 1462672 A	26-01-1977
		JP 50047180 A	26-04-1975
		SE 403950 B	11-09-1978
		SE 7410339 A	17-02-1975
US 4404424 A	13-09-1983	CA 1191914 A	13-08-1985